Appl. No. 10/784,473
Amendt./Reply dated April 28, 2006
Reply to Office Action of Jan. 25, 2006

REMARKS / ARGUMENTS

In response to a first office action of January 26, 2006, Applicant has clarified distinctions between the claimed invention and the cited references. Therefore, reconsideration and allowance of the specification and pending claims are respectfully requested.

I. Invention Overview

The invention subject to the present Application is a direct antifreeze cooled fuel cell power plant with passive water management that includes at least one fuel cell having a wetproofed anode support and a cathode support for directing reactant streams adjacent fuel cell catalysts. A porous anode cooler plate (26) has its fuel channels (28A, 28B, 28C, 28D) defined on a first surface and a plurality of coolant channels (32A, 32B, 32C, 32D) defined on an opposed second surface, and the anode cooler plate is secured so that its fuel channels are adjacent an anode support (20) to direct the fuel through the anode support to the anode catalyst. A porous cathode water management plate (38) has its oxidant channels (40A, 40B, 40C, 40D) secured adjacent a cathode support (24).

A direct antifreeze solution passes only through the coolant channels (32A, 32B, 32C, 32D) of the anode cooler plate (26) so the solution cannot poison fuel cell catalysts (14, 16). Fuel cell product water flows passively through the cathode water management plate (38) and water management channels (44A,

44B, 44C, 44D) defined in the plate (38) to humidify reactant streams and to be discharged from the fuel cell.

An impervious separator plate (36) is secured adjacent the coolant channels of the anode cooler plate for prohibiting movement of the direct antifreeze solution through the separator plate. Pressure control means maintain a positive pressure differential between the fuel stream passing through the fuel channels of the anode cooler plate and the direct antifreeze solution passing through the coolant channels of the anode cooler plate.

By use of the separator plate and the pressure control means, the direct antifreeze solution cannot leave the anode cooler plate to pass through the anode support to contact and poison the catalysts. However, the cathode water management plate permits fuel cell product water to move passively from the fuel cell catalysts into and through pores and water management channels of the cathode water management plate in fluid communication with a fuel cell water discharge to passively humidify the oxidant reactant stream and direct excess fuel cell product water out of the fuel cell power plant.

Extensive usage of the "direct antifreeze solution" of the present invention by the inventor and the assignee of all rights in the present invention in prior art fuel cells gave rise to a need to further limit contact by the direct antifreeze solution on fuel cell catalysts. By use of the combined separator plate,

pressure control means, and passive water movement through the cathode cooler plate, the present invention achieves water management of fuel cell product water, humidification of reactant streams, and efficient used of the direct antifreeze solution to tolerate sub-freezing ambient operating conditions without contaminating the catalysts with the direct antifreeze solution.

II. Response to Office Action

By the January 25, 2006 first office action, the Examiner has first rejected the only independent claim, claim 1, and claims 2 - 4, 6 and 7 as being unpatentable under 35 U.S.C. Sec. 103(a) over U.S. Patent 6,416,891 to Condit et al. in view of U.S. Patent 6,461,753 to Breault et al.

As stated in Section 2143.03 of the Manual of Patent Examining Procedure ("M.P.E.P."): "To establish *prima facie* obviousness of a claimed invention, all of the claimed limitations must be taught or suggested by the prior art." It is the position of the Applicant that neither of the cited references show or suggest a "separator plate" as claimed in independent claim 1 of the present invention. Therefore, it is urged that both references be removed and that claim 1 be allowed. That same M.P.E.P. Sec. 214.03 states: "If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious." Because claim 1 should be allowable for reasons recited above and below, it is also urged that the Examiner's rejections of dependent claims 2

- 7 should also be removed and those claims also be allowed.

The Examiner urged in his Jan. 25 office action that: "With respect to clam 1, Condit et al. teach a fuel cell power plant for generating power comprising a least one fuel cell having an electrolyte (62), and anode catalyst (64), a cathode catalyst (66), and anode support means, a cathode support means, a porous anode water transport plate (68) (anode cooler plate), and antifreeze solution, a porous cathode water transport plate (74) (cathode water management plate), and water support plates (separator plate) that are adjacent to the porous anode and cathode water transport plates and form a network of coolant channels for delivering the coolant to the water transport plates. See Column 9, Line 10 to Column 10, Line 18. However, Condit et al. do not teach or suggest the addition of a pressure control means…." (Emphasis added.)

The Examiner appears to be urging the above description of elements appearing in Condit et al. as showing or suggesting elements in claim 1 in sub-headings a – e ("a", being "at least one fuel cell…"; b, "a porous anode cooler plate…"; c. "a direct antifreeze solution…"; d. "a separator plate…"; and, e. "a porous cathode water management plate…"), but for element f ("f" being pressure control means…"), one must look to Breault et al. The undersigned insists, however, that Condit et al. does not show or suggest the element in sub-heading d, "a separator plate".

Claim 1 at sub-heading d describes the "separator plate" as follows:

> d. a separator plate (36) secured adjacent the coolant channels (32A, 32B, 32C, 32D) of the anode cooler plate (26) for prohibiting movement of the direct antifreeze solution through the separator plate (36); (Emphasis added.)

As recited above, the structure of the separator plate being such that it is capable of "prohibiting movement of the direct antifreeze solution through the separator plate" is a critical aspect of the invention. This is emphasized throughout the Specification. For example: "An impervious separator plate is secured adjacent the coolant channels of the anode cooler plate for prohibiting movement of the direct antifreeze solution through the separator plate." (Specification at page 4, lines 24-29.) Again, at page 5, lines 30-34: "Use of the impervious separator plate and wetproofed anode support means prohibits movement of the direct antifreeze solution out of the anode cooler plate so that the direct antifreeze solution cannot contact and poison the cathode catalyst." Those quotes are from the summary, or "Disclosure of the Invention" section of the Specification. In the more detailed "Description of the Preferred Embodiment", the same point is reiterated: "An impervious separator plate 36 is secured adjacent the coolant channels 32A, 32B, 32C, 32D of the [porous anode] cooler plate 26, and is dimensioned to overlie the cooler plate 26 so that

any fluid coolant or reactant is prohibited from moving from the cooler plate 26 through the separator plate 36."

The undersigned stresses that, as in claim 1, this description specifically recites a location of the "separator plate 36" with respect to the "plurality of fuel channels 28A, 28B, 28C, 28D" that are defined "on a first surface 30 of the [anode cooler plate 26]…' and, a "plurality of coolant channels 32A, 32B, 32C, 32D [that] are on an opposed second surface 34 of the [porous anode cooler] plate 26. The cooler plate 26 is secured to the anode support means so that the fuel channels 28A, 28B, 28C, 28D are adjacent the anode support means…." (Specification at page 9, lines 8-22.) And, the "separator plate 36 is secured adjacent the coolant channels 32A, 32B, 32C, 32D…." (Id.) Consequently flow of the direct antifreeze solution and fuel through the channels defined within the anode cooler plate 26 is between the impervious separator plate 36 and the anode catalyst 14.

A significant beneficial impact of the structure of the fuel cell power plant of claim 1 is described with respect to the value of containing the direct antifreeze within the porous anode cooler plate and coolant channels defined therein in the Specification at Page 13, line 31 - Page 14, line 9, as follows:

> As is well known in the art, in most operational circumstances the at least one fuel cell 62 shown in FIG. 3 would be integrated with a plurality of similar

fuel cells (not shown) to form a cell stack assembly (not shown). In such an assembly, an additional fuel cell would be secured to the fuel cell 62 so that a separator plate (not shown) adjacent an anode cooler plate of the additional fuel cell would be secured adjacent the water management plate 104 of the fuel cell 62 to prohibit movement of any direct antifreeze within the cooler plate of the additional fuel cell from moving into the cathode water management plate 104. For such a fuel cell stack assembly of the present invention there would be at least one impervious plate between adjacent fuel cells.

The undersigned stresses the above description is not to be confused with the "fuel cell stack assembly" of claim 6. Instead, the description in the specification serves to emphasize a value of the structure of the "separator plate" of claim 1.

As is apparent from the above, the "separator plate 36" of claim 1 is impervious so that it is capable of "prohibiting movement of the direct antifreeze solution through the separator plate (36)". (Specification at Page 19, claim 1, lines 27 - 31.) Consequently, by effectively sealing the "direct antifreeze solution" between the separator plate and the coolant channels defined with in the "porous anode cooler plate (26)" (Id.), while at the same time permitting passive movement of the fuel cell product water through the "water management channels"

and pores of the "porous cathode water management plate (38)" (Claim 1), the fuel cell power plant of claim 1 achieves efficient water management while preventing contamination of the fuel cell catalysts with the direct antifreeze solution.

In contrast, the operating system for a direct antifreeze cooled fuel cell power plant of Condit et al. does not include any structure that can isolate the direct antifreeze solution from contact with fuel cell catalysts. Indeed, in the "Background Art" section of the present Specification, the Applicant specifically identified Condit et al. as disclosing a system that gave rise to difficulties the present invention seeks to solve. (See the Specification at Page 2, line 22 - Page 3, line 7.)

The Examiner urges that "water support plates (separator plate)" are taught by Condit et al. in Col. 9, line 10 - Col. 10, line 18. While "support means" are disclosed in that part of the patent, they are invariably "porous" layers on both the anode and cathode side of the fuel cell catalysts. For example, at Col. 9, lines 15 - 29 an "anode support means" is disclosed, and described as "[t]he anode support means may include one or more porous layers, such as a porous anode substrate 70, a porous anode diffusion layer 72, or both [of the layers]". Moreover, the anode support means is characterized as being "secured in direct fluid communication with the anode catalyst 64 between and anode water transport plate 68 and the anode catalyst for passing the reducing fluid stream adjacent the

anode catalyst 64." (Condit et al. at Col. 9, lines 14 - 19.) As seen in the same column of Condit al. the "cathode support means" is essentially the same, including "porous" layers. Moreover, the "anode water transport plate 68" "may be structured to cooperate with adjacent water transport plates ... so that anode side coolant channels 88A, 88B and 88C are defined within the anode water transport plate 68,..." (Condit et al. at Col. 10, lines 9 - 14.)

Therefore, by asserting that "water support plates (separator plate) that are adjacent to the porous anode and cathode water transport plates" (office action at Page 1, Sec. 2.) found in the cited section of Condit et al. teach or suggest the "separator plate (36)" of Applicant's claim 1, the Examiner is apparently urging that the "anode support" "porous plates" of Condit et al. teach or suggest Applicant's "separator plate (36)" of claim 1. However, as shown above, the Condit et al. "water support plates" do not teach or suggest Applicant's "separator plate" for at least two reasons. First, the Condit et al. plates are secured in a different location than the "separator plate" of claim 1. The Condit et al. "water support plates" are secured between an anode water transport plate and an anode catalyst. Applicant's "separator plate" is secured adjacent coolant channels of the anode cooler plate. Second, the Condit et al. plates are porous, and hence are not capable of "prohibiting movement of the direct antifreeze solution through the plate", as does Applicant's "separator plate". (Specification at Claim 1.)

To the extent that the Examiner may be suggesting Condit et al. otherwise teaches or suggests an impervious "separator plate" that keeps the direct antifreeze solution from moving out of the coolant channels defined in, or pores of, an anode water transport or coolant plate, it is strenuously urged that Condit et al. specifically teaches away from any such possibility. For example, at Col. 10, lines Condit et al. discloses:

> As shown in FIG. 2, the porous anode and cathode water transport plates 68, 74 may be structured to cooperate with adjacent water transport plates (not shown) so that anode side coolant channels 88A, 88B and 88C defined within the anode water transport plate 68, and cathode side coolant channels 90A, 90B, and 90C defined within the cathode water transport plate 74 may cooperate in mirror-image association with coolant channels of the adjacent water transport plates of adjacent fuel cells (not shown) in a cell stack assembly to form a network of coolant channels for delivering a cooling fluid stream to the water transport plates 68, 74.

This shows that the "mirror-image association" of the coolant channels provides for an efficient manufacture of one form of water transport plate that cooperates with an adjacent water transport plate to deliver coolant to both plates. Clearly, use of a "separator plate 36 secured adjacent the coolant channels ... of the anode cooler plate (26) for

prohibiting movement of the direct antifreeze solution through the separator plate (36)" (Specification at claim 1.) would unquestionably frustrate the above described advantage and function of the Condit et al. water transport plates. Therefore, Condit et al. does not show, does not suggest, and specifically teaches away from use of a "separator plate" for prohibiting movement of the direct antifreeze solution through the separator plate, as claimed in the only independent claim of the present application.

Additionally, the other above cited prior art reference, Breault et al, does not teach or suggest the separator plate of Applicant's pending claim 1, and the undersigned hastens to add that the Examiner did not assert that Breault et al. shows or suggests a separator plate.

(For purposes of explanation, it is pointed out that Condit et al., and similar such patents utilizing porous water transport plates provide for separation of the gaseous oxidant and reducing fluid reactant streams by "filling the open pore volume of the anode and cathode water transport plates 68, 74 [so that] the cooling fluid stream of the direct antifreeze solution [within the open pore volume of the plates] forms a gas barrier or seal preventing..." mixing of the reactant streams. (See Condit et al., at Col. 10, lines 28 - 33.))

Accordingly, because all of the claim limitations of Applicants only pending independent claim are not taught or

suggested by the prior art, it is respectfully requested that Condit et al. be removed as a reference. Moreover, because by the removal of Condit et al. as a reference, independent claim 1 should be allowable, and all of the remaining claims, claims 2 - 7, depend from claim 1, it is also respectfully urged that claims 2 - 7 be allowed as well.

III. Conclusion

By the argument presented above it is respectfully urged that all of the Examiner's concerns raised in the first office action have been resolved. Accordingly, it is respectfully requested that the Examiner remove the rejections of the pending claims, and issue a Notice of Allowance.

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